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Solid Earth, 5, 569-584, 2014
www.solid-earth.net/5/569/2014/
doi:10.5194/se-5-569-2014

Research Article

30 Jun 2014

Future Antarctic bed topography and its implications for ice sheet dynamics

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Received: 24 Dec 2013 – Published in Solid Earth Discuss.: 17 Jan 2014
Revised: 09 May 2014 – Accepted: 12 May 2014 – Published: 30 Jun 2014

Abstract. The Antarctic bedrock is evolving as the solid Earth responds to the past and ongoing evolution of the ice sheet. A recently improved ice loading history suggests that the Antarctic Ice Sheet (AIS) has generally been losing its mass since the Last Glacial Maximum. In a sustained warming climate, the AIS is predicted to retreat at a greater pace, primarily via melting beneath the ice shelves. We employ the glacial isostatic adjustment (GIA) capability of the Ice Sheet System Model (ISSM) to

combine these past and future ice loadings and provide the new solid Earth computations for the AIS. We find that past loading is relatively less important than future loading for the evolution of the future bed topography. Our computations predict that the West Antarctic Ice Sheet (WAIS) may uplift by a few meters and a few tens of meters at years AD 2100 and 2500, respectively, and that the East Antarctic Ice Sheet is likely to remain unchanged or subside minimally except around the Amery Ice Shelf. The Amundsen Sea Sector in particular is predicted to rise at the greatest rate; one hundred years of ice evolution in this region, for example, predicts that the coastline of Pine Island Bay will approach roughly 45 mm yr^{-1} in viscoelastic vertical motion. Of particular importance, we systematically demonstrate that the effect of a pervasive and large GIA uplift in the WAIS is generally associated with the flattening of reverse bed slope, reduction of local sea depth, and thus the extension of grounding line (GL) towards the continental shelf. Using the 3-D higher-order ice flow capability of ISSM, such a migration of GL is shown to inhibit the ice flow. This negative feedback between the ice sheet and the solid Earth may promote stability in marine portions of the ice sheet in the future.

Citation: Adhikari, S., Ivins, E. R., Larour, E., Seroussi, H., Morlighem, M., and Nowicki, S.: Future Antarctic bed topography and its implications for ice sheet dynamics, Solid Earth, 5, 569-584, doi:10.5194/se-5-569-2014, 2014.